REMARKS

The Official Action mailed June 25, 2003, has been received and its contents carefully noted. Filed concurrently herewith is a *Request for Two Month Extension of Time*, which extends the shortened statutory period for response to November 25, 2003. Accordingly, the Applicants respectfully submit that this response is being timely filed.

The Applicants note with appreciation the consideration of the Information Disclosure Statements filed on July 28, 1999, February 11, 2002, and February 15, 2002.

Claims 45-50, 52-54, 56-58, 60-62, 64, 65 and 67-72 are pending in the present application, of which claims 45, 49, 52, 56, 60 and 64 are independent. Claims 45, 49, 52, 56, 60 and 64 have been amended to better recite the features of the present invention, and claims 60 and 64 have been amended to correct a minor typographical error. For the reasons set forth in detail below, these claims are believed to be in condition for allowance.

The Official Action rejects claims 45, 47, 60, 62 and 67-72 as obvious based on the combination of U.S. Patent No. 5,858,819 to Miyasaka and U.S. Patent No. 5,851,860 to Makita et al., and claims 46, 49, 50, 52-54, 56-58, 61 and 64-66 as obvious based on the combination of Miyasaka '819, Makita and U.S. Patent No. 6,066,516 to Miyasaka. The Applicants respectfully traverse the rejection because the Official Action has not made a *prima facie* case of obviousness.

As stated in MPEP §§ 2143-2143.01, to establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. Obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion, or motivation to do so found either explicitly or implicitly in the

references themselves or in the knowledge generally available to one of ordinary skill in the art. "The test for an implicit showing is what the combined teachings, knowledge of one of ordinary skill in the art, and the nature of the problem to be solved as a whole would have suggested to those of ordinary skill in the art." *In re Kotzab,* 217 F.3d 1365, 1370, 55 USPQ2d 1313, 1317 (Fed. Cir. 2000). See also *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988); *In re Jones*, 958 F.2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992).

The independent claims, as amended, recite providing a material for promoting crystallization (or at least one metal element) to at least a part of a semiconductor film formed over a substrate, subjecting the semiconductor film to oxygen plasma, and crystallizing the semiconductor film after subjecting the semiconductor film to the oxygen plasma to obtain a crystalline semiconductor film (claims 45, 52 and 60) or irradiating the semiconductor film after subjecting the semiconductor film to the oxygen plasma with one of an infrared ray and a laser light (claims 49, 56 and 64).

The Applicants have observed two advantages of crystallization using a metal element, that is, a small number of defects in each grain and continuous grain boundaries. Also, the Applicants have observed an advantage in subjecting a semiconductor film to oxygen plasma, that is, homogenizing grain size. Further, the Applicants have observed an unexpectedly superior uniformity in the crystallization of the semiconductor film despite a decrease in grain size due to subjecting the semiconductor film to the oxygen plasma. Still further, the Applicants have performed these two steps together in the same method and this method has an unexpected advantage of promoting crystallization by providing a material for promoting crystallization (or at least one metal element) to at least a part of a semiconductor film formed over a substrate while improving the uniformity of semiconductor films and TFTs made therefrom.

There is no suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify Miyasaka '819 and Makita or to combine reference teachings to achieve the claimed invention.

The Official Action concedes that "Miyasaka also fails to teach ... the step of contacting a material for promoting crystallization to at least part of the semiconducting film formed over the substrate" (page 2, Paper No. 28). The Official Action asserts that "[such] a step is well known and is taught by Makita" and that "[it] would have been obvious to one of ordinary skill in the art at the time of the invention to combine this step with the step of using oxygen plasma, as the use of a metal catalyst to promote crystallization is well known, and one of ordinary skill in the art would [have] known that combining such two steps, each of which enhances crystallization, together, would further improve the overall level of crystallization" (pages 2-3, Id.). The Applicants respectfully disagree and traverse the above-referenced assertions in the Official Action.

Miyasaka '819 appears to teach exposing a semiconductor film to oxygen plasma, but does not teach or suggest exposing a semiconductor film to metal catalyst. Specifically, Miyasaka '819 appears to disclose exposing a semiconductor film 103 to oxygen plasma (column 24, line 40), forming a silicon oxide film (not shown) on the semiconductor film surface (column 24, line 43), desirably removing the silicon oxide film prior to crystallization (column 25, line 25), and crystallizing the semiconductor film 103 immediately after removal of the oxide film (column 25, line 39). The oxygen plasma exposure in Miyasaka '819 is conducted in order to achieve "the same type of effect" as the application of a hydrogen plasma treatment, that is to reduce dangling bonds on a semiconductor film. Miyasaka '819 does not teach or suggest that the oxygen plasma process has anything to do with the grain size of crystals, much less the homogenization of the grain size of crystals. Miyasaka '819 does not teach or suggest that the oxygen plasma process should be conducted along with a metal catalyst process. Makita appears to teach a catalyst element for promoting a crystallization of an amorphous silicon film without teaching or suggesting subjecting a semiconductor film to oxygen plasma. Makita also does not teach or suggest using the methods of Miyasaka '819 together with the methods of Makita.

The Applicants respectfully submit that it is not obvious to provide a material for promoting crystallization (or at least one metal element) to at least a part of a

semiconductor film formed over a substrate, subject the semiconductor film to oxygen plasma, and crystallize the semiconductor film after subjecting the semiconductor film to the oxygen plasma to obtain a crystalline semiconductor film or irradiate the semiconductor film after subjecting the semiconductor film to the oxygen plasma with one of an infrared ray and a laser light. The Applicants further respectfully submit that it would not have been within the ordinary skill of the artisan at the time of the invention to perform the above-referenced features of the present invention.

The Applicants will file a *Declaration Under 37 CFR § 1.132* in order to show the above-referenced advantages of the present invention. An unexecuted *Declaration* is attached herewith. As shown in the *Declaration*, the Applicants have observed with an optical microscope a semiconductor film crystallized using a metal element (nickel) without subjecting the semiconductor film to oxygen plasma. Using this process, the Applicants have observed that the size of crystal grains is relatively large. The sample is formed by the steps of depositing an amorphous silicon film having a thickness of 690 Å over a quartz substrate by LPCVD, applying a solution containing nickel to the amorphous silicon film by spin coating and crystallizing the amorphous film by heating at 600°C for 12 hours after applying the solution containing nickel.

In accordance with the present invention, the Applicants have observed with an optical microscope a semiconductor film crystallized using a metal element (nickel) after subjecting the semiconductor film to oxygen plasma. Using this process, the Applicants have observed that the size of crystal grains is relatively small as compared to the process described above. The sample is formed by the steps of depositing an amorphous silicon film having a thickness of 600 Å over a quartz substrate by LPCVD, subjecting oxygen plasma to the amorphous silicon film, applying a solution containing nickel to the amorphous silicon film by spin coating after subjecting oxygen plasma and crystallizing the amorphous silicon film by heating at 600°C for 12 hours after applying the solution containing nickel.

As noted above, the Applicants have observed that the grain size of the semiconductor film in the first process is much larger than in the second process using

oxygen plasma. While the electrical characteristics of the TFTs can be generally improved by increasing the grain size, the uniformity of the electrical characteristics among the TFTs tends to become worse if the grain size is large. This is because the electrical characteristics tend to depend upon the existence of grain boundaries in the channel region. If the grain size is large, the number of grain boundaries existing in the channel region is small but the TFT properties vary more apparently depending upon the existence of the grain boundaries. On the other hand, if the grain size is relatively small, the number of grain boundaries in the channel region can be averaged so that the TFT properties do not so vary.

As such, one of ordinary skill in the art would tend to avoid using oxygen plasma in order to promote crystallization. The present inventors have found that the combination of the use of oxygen plasma along with a metal for promoting crystallization produces a synergistic effect in that the oxygen plasma promotes uniform and homogenous crystallization while the catalyst promotes a crystal with a small number of defects and continuous grain boundaries. Therefore, the present invention has an unexpected advantage of promoting crystallization by the use of a metal for promoting crystallization while improving the uniformity of semiconductor films and TFTs made therefrom.

In view of the *Declaration*, the Applicants respectfully submit that the Applicants have observed two advantages of crystallization using a metal element, that is, a small number of defects in each grain and continuous grain boundaries, and a further advantage of the use of oxygen plasma, that is, homogenizing grain size. In order to make use of these advantages, the Applicants developed a method for manufacturing a semiconductor device comprising the steps of providing a material for promoting crystallization (or at least one metal element) to at least a part of a semiconductor film formed over a substrate, subjecting the semiconductor film to oxygen plasma, and crystallizing the semiconductor film after subjecting the semiconductor film to the oxygen plasma to obtain a crystalline semiconductor film or irradiating the semiconductor film after subjecting the semiconductor film to the oxygen plasma with

one of an infrared ray and a laser light. The Applicants respectfully submit that the prior art of record does not teach or suggest the desirability of a combination of Miyasaka '819 with Makita, specifically, a combination of providing a material for promoting crystallization (or at least one metal element) to at least a part of a semiconductor film formed over a substrate, and subjecting the semiconductor film to oxygen plasma.

The Applicants further contend that even assuming, *arguendo*, that the combination of Miyasaka '819 and Makita is proper, there is a lack of suggestion as to why a skilled artisan would use the proposed modifications to achieve the unobvious advantages first recognized by the Applicants. The mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination.

Miyasaka '516 does not cure the deficiencies in the motivation to combine Miyasaka '819 and Makita. The Official Action relies on Miyasaka '516 to allegedly teach crystallizing a semiconductor film with a laser light (page 3, Paper No. 28). Miyasaka '516 does not teach or suggest the desirability of a combination of Miyasaka '819 with Makita.

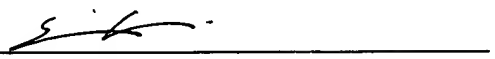
In the present application, it is respectfully submitted that the prior art of record, alone or in combination, does not expressly or impliedly suggest the claimed invention and the Official Action has not presented a convincing line of reasoning as to why the artisan would have found the claimed invention to have been obvious in light of the teachings of the references.

For the reasons stated above, the Official Action has not formed a proper *prima facie* case of obviousness. Accordingly, reconsideration and withdrawal of the rejections under 35 U.S.C. § 103(a) are in order and respectfully requested.

The Applicants note that dependent claim 48 has not been formally rejected. It is respectfully submitted that claim 48 is allowable for the reasons stated above.

Should the Examiner believe that anything further would be desirable to place this application in better condition for allowance, the Examiner is invited to contact the Applicants' undersigned attorney at the telephone number listed below.

Respectfully submitted,



Eric J. Robinson
Reg. No. 38,285

Robinson Intellectual Property Law Office, P.C.
PMB 955
21010 Southbank Street
Potomac Falls, Virginia 20165
(571) 434-6789